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Gamma-ray Large Area Space Telescope (GLAST)

Large Area Telescope (LAT)

Calorimeter Performance Exceptions List Definition

DOCUMENT APPROVAL

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CHANGE HISTORY LOG

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1 INTRODUCTION

1.1 PURPOSE

This document defines the CAL Performance Exceptions list, which is used to identify Calorimeter channels whose performance is outside the specification or sufficiently outside the family to warrant special treatment. For functional testing, that special treatment is exclusion from evaluation of the relevant pass/fail criteria.

1.2 SCOPE

The Performance Exception List may be applied to any flight CAL Module.

1.3 APPLICABLE DOCUMENTS

The following documents are applicable to the extent specified within. Unless otherwise indicated, the latest issue in effect shall apply.

LAT-SS-00010	LAT Performance Specification – Level II (b) Specification
LAT-SS-00018	LAT CAL Subsystem Specification - Level III Specification
LAT-SS-00210	LAT CAL Subsystem Specification – Level IV Specification
LAT-TD-01502	LAT Calorimeter Subsystem Test Descriptions
LAT-MD-04187	CAL Electronic and Muon Calibration Definition
LAT-PS-01513	CAL Functional Test and Calibration Procedure

1.4 DEFINITIONS AND ACRONYMS

1.4.1 Acronyms

CAL	Calorimeter Subsystem of the LAT
CDE	Crystal Detector Element
GLAST	Gamma-Ray Large Area Space Telescope
LAT	Large Area Telescope
PDA	PhotoDiode Assembly
TBD	To Be Determined
TBR	To Be Resolved

2 INTRODUCTION

Either through explicit failure or evolution with time, some channels of the CAL Modules may have performance that fails to meet the relevant specifications or that falls outside the family of the remainder of the channels. Such channels may need to be flagged for special treatment, whether that is marking them for additional monitoring of trends, excluding them from further pass/fail criteria evaluation, modifying their use in science analysis, etc.

The identity of these exceptional channels, along with the manner in which they are unusual, shall be documented within the CAL Performance Exceptions List.

The Exceptions List is organized with regard to CAL functionality rather than specific hardware components. For example, an FLE discriminator may not be functioning because of failures within the GCFE, GCRC, GCCC, etc.

The CAL FMEA allows for failure of a few percent of CAL channels. The Module and LAT-level functional tests must therefore contain a mechanism to accommodate such "acceptable" failures. The Exceptions List then allows a Module or LAT to be tested to the defined specifications by labeling the failed channels as exempt from testing.

2.1 FORMAT

The Exceptions List shall be written in XML. This format was chosen for portability, readability, and ease of documentation. The list shall be sparse, containing entries only for identified exceptions.

The XML definition is given in Section 0.

Exceptional channels shall be identified by Module number, CAL Cable Controller number, CAL Readout Controller number, and CAL Front End number. The exceptional condition shall be indicated for each exceptional channel, and multiple exceptions shall be listed together as a group for each exceptional channel.

2.2 EPOCH OF VALIDITY

There may be distinct exceptions lists for ground and flight operations to account for failures that are applicable only to one condition or another. For example, there might be an FLE discriminator that was too noisy to be set below ~10 MeV for ground muon tests but functions adequately at the flight setting of ~100 MeV. The epoch or condition of validity is not documented within the Exceptions List, so this information must be encoded or tracked through some other mechanism.

3 PERFORMANCE EXCEPTIONS LIST

3.1 TYPES OF EXCEPTIONS

Performance exceptions may be one (or more) of several functional types or categories. For simplicity, we have grouped the exceptions into three types: those affecting the performance of triggering, spectroscopy, or data volume.

3.1.1 Triggering

The first class of exceptions affects the ability of CAL-LO or CAL-HI triggers to be generated or their respective primitives, i.e. FLE and FHE discriminators, to be asserted. Exceptional trigger discriminators may be "dead" or "noisy." A "dead" discriminator does not fire. A "noisy" discriminator may have a particularly high minimum threshold at which it operates without running away, or it may have a particularly broad range over which it may or may not fire (i.e. where its efficiency is somewhere between 0 and 1). Discriminators that are noisy at settings appropriate for muons may not be noisy at flight settings.

Noisy or dead trigger discriminators will affect all CAL trigger functional tests (all tests with names beginning "calf_trg_p"). Verification shall be disabled for all trg_p* unit tests.

For triggering, all log-ends are independent. There are 192 FLE and 192 FHE discriminators per CAL Module. Thus the exception list for each Module may contain flags for up to 192 noisy FLEs, 192 dead FLEs, 192 noisy FHEs, and 192 dead FHEs.

3.1.2 Spectroscopy

The second class of exceptions affects the ability of CAL energy channels to perform spectroscopy. The four energy ranges

An energy range may be "dead" if there is no signal, or if the range-discriminator is not functioning or does not select the energy range. An energy range may be "noisy" if it shows anomalously broad pedestals or charge-injection peaks.

For noisy energy ranges, verification shall be disabled for the following unit tests: pedestals_ci, shp_p*, gain_p01, adc_p02, adc_p05, supp_p02, ovr_p01, and trg_p*. For dead energy ranges, verification shall be disabled for all unit tests.

There are 192 log-ends, each with four energy ranges, per Module. Although most failures will result in simultaneous failure of a X8 and X1 range pair, we will allow for independent entries for each range. Thus the exception list for each Module may contain flags for up to 192 noisy LEX8 ranges, 192 dead LEX8 ranges, 192 noisy LEX1 ranges, 192 dead LEX1 ranges, 192 noisy HEX8 ranges, 192 dead HEX8 ranges, 192 noisy HEX1 ranges, and 192 dead HEX1 ranges.

3.1.3 Data volume

The third class of exceptions affects the CAL data volume or zero suppression through a discrepancy in the log-accept discriminator (LAC). Again, the LAC discriminator may be non-functioning ("dead") or noisy. A "noisy" LAC discriminator is one that fires at an anomalously high energy.

3.2 DEFINITION

The following table defines the entries in the exception list. For each entry, the CAL unit tests that shall be disabled for the exceptional channel are listed.

Class	Exception	Affected Tests
Triggering		
	Noisy FLE	trg_p*
	Noisy FHE	trg_p*
	Dead FLE	trg_p*
	Dead FHE	trg_p*
Spectroscopy		
	Noisy LEX8	pedestals_ci, shp_p*, gain_p01, adc_p02, adc_p05, supp_p02, ovr_p01, trg_p*
	Noisy LEX1	pedestals_ci, shp_p*, gain_p01, adc_p02, adc_p05, supp_p02, ovr_p01, trg_p*
	Noisy HEX8	pedestals_ci, shp_p*, gain_p01, adc_p02, adc_p05, supp_p02, ovr_p01, trg_p*
	Noisy HEX1	pedestals_ci, shp_p*, gain_p01, adc_p02, adc_p05, supp_p02, ovr_p01, trg_p*
	Dead LEX8	(all)
	Dead LEX1	(all)
	Dead HEX8	(all)
	Dead HEX1	(all)
Data Volume		
	Noisy LAC	supp_p*
	Dead LAC	supp_p*

Table 1: Exceptions list

3.3 XML DEFINITION

The root element shall be calExcept, with the Module serial number as its attribute. The root may contain 0 or more child elements, Chan.

The child element Chan shall have attributes GTEM for TEM ID, GCCC for CAL cable controller ID, GCRC for row ID, and GCFE for column ID. The ID numbering convention shall comply with LAT standards; thus GTEM shall number 0 to 15 for the 16 towers; GCCC shall number 0 to 3 corresponding to the X+, Y+, X-, and Y- cable controllers; GCRC shall number 0 to 3 corresponding to readout controller rows, and GCFE shall number 0 to 11 corresponding to CDE column number. The Chan element therefore specifies a single GCFE chip, with its FLE, FHE, and LAC discriminators and four energy ranges.

The element Chan shall have child elements Noisy and Dead. There may be 0 or 1 Noisy child and 0 or 1 Dead Child.

The following text contains the XML Document Type Definition, called calExcept.dtd.

```
<?xml version="1.0" encoding="UTF-8"?>
<!ELEMENT calExcept     (Chan*)>

<!ELEMENT Chan    (Noisy?, Dead?)>
```

```
<!ELEMENT Noisy    (LEX8?, LEX1?, HEX8?, HEX1?, FLE?, FHE?, LAC?)>
<!ELEMENT Dead     (LEX8?, LEX1?, HEX8?, HEX1?, FLE?, FHE?, LAC?)>

<!ELEMENT LEX8     (#PCDATA)>
<!ELEMENT LEX1     (#PCDATA)>
<!ELEMENT HEX8     (#PCDATA)>
<!ELEMENT HEX1     (#PCDATA)>
<!ELEMENT FLE      (#PCDATA)>
<!ELEMENT FHE      (#PCDATA)>
<!ELEMENT LAC      (#PCDATA)>

<!ATTLIST calExcept      #REQUIRED>
<!ATTLIST Chan     GTEM  (0|1|2|3|4|5|6|7|8|9|10|11|12|13|14|15) #REQUIRED
                   GCCC  (0|1|2|3)    #REQUIRED
                   GCRC  (0|1|2|3)    #REQUIRED
                   GCFE  (0|1|2|3|4|5|6|7|8|9|10|11)    #REQUIRED>
```

3.4 EXAMPLE EXCEPTIONS LIST

This section contains example XML documents that conform with the proposed Exceptions List definition. Note that these examples are indeed more verbose than required, since they both contain entries that repeat the default "False" condition.

The following XML code describes the true performance of CAL Module FM107, which has one GCFE with broad pedestals in the LEX8 and LEX1 ranges.

```
<?xml version="1.0"?>
<!DOCTYPE calExcept SYSTEM "calExcept.dtd">
<calExcept calSN="FM107">
      <Chan GTEM="0" GCCC="2" GCRC="3" GCFE="2">
            <Noisy>
                  <LEX8>True</LEX8>
                  <LEX1>True</LEX1>
                  <HEX8>False</HEX8>
                  <HEX1>False</HEX1>
                  <FLE>False</FLE>
                  <FHE>False</FHE>
                  <LAC>False</LAC>
            </Noisy>
            <Dead>
                  <LEX8>False</LEX8>
                  <LEX1>False</LEX1>
                  <HEX8>False</HEX8>
                  <HEX1>False</HEX1>
                  <FLE>False</FLE>
                  <FHE>False</FHE>
                  <LAC>False</LAC>
            </Dead>
      </Chan>
</calExcept>
```

The following XML code describes the true performance of CAL Module FM105, which has one GCFE with a noisy FLE threshold, i.e. a threshold that cannot be set near or below the muon peak.

```
<?xml version="1.0"?>
<!DOCTYPE calExcept SYSTEM “calExcept.dtd”>
<calExcept calSN="FM105">
      <Chan GTEM="0" GCCC="2" GCRC="0" GCFE="10">
            <Noisy>
                  <FLE>true</FLE>
                  <FHE>false</FHE>
                  <LAC>false</LAC>
            </Noisy>
      </Chan>
</calExcept>
```